GYPSY MOTH NEWS

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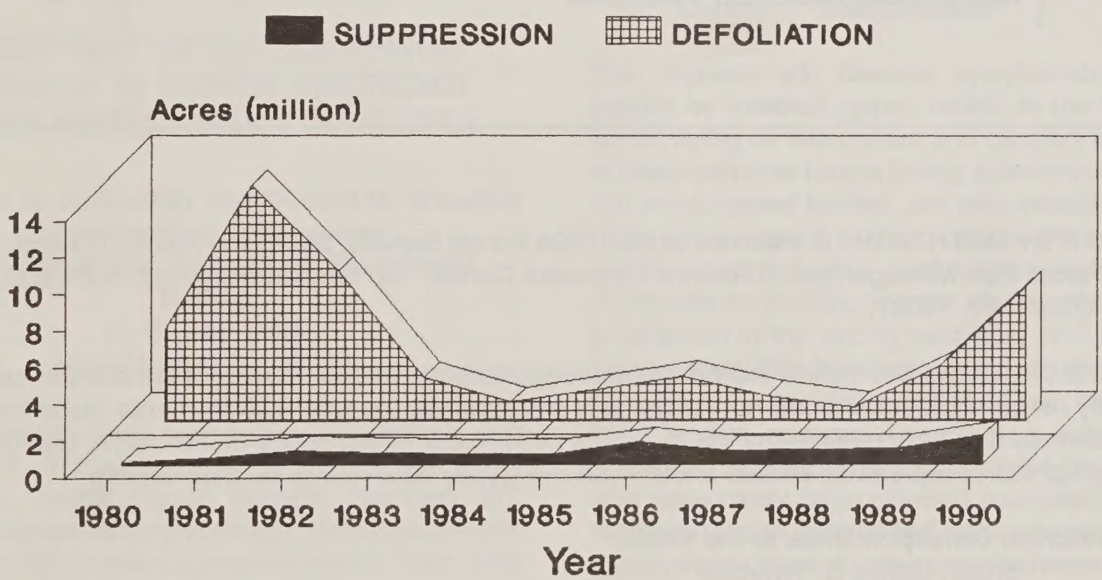
GYPSY MOTH DEFOLIATION AND SUPPRESSION 1980-1990



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Gypsy Moth News
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Editor's Note: The discovery in 1989 of a fungal disease of gypsy moth in the Northeast has generated widespread interest in the hope of having found a naturally occurring agent capable of controlling outbreaks. To date, this disease has been found infecting larvae in areas of Connecticut, Rhode Island, New Hampshire, Vermont, eastern New York, eastern Pennsylvania and New Jersey. In Connecticut it appears to have caused populations to collapse two years in a row. Following are two summaries of recently published papers describing the disease, its discovery and isolation, symptomatology and impact.

The first paper by Andreadis and Weseloh provides some background about the disease and its occurrence in Connecticut. The second by Hajek et al. describes the isolation of the fungus, its more general distribution, and a theory about its occurrence with respect to rainfall.

DISCOVERY OF *ENTOMOPHAGA MAIMAIGA* IN NORTH AMERICAN GYPSY MOTH, *LYMANTRIA DISPAR*

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Article adapted from: Andreadis, Theodore G., and Ronald M. Weseloh with the assistance of M. McManus, USDA Forest Service, Hamden, CT. 1990. Discovery of *Entomophaga maimaiga* in North American Gypsy Moth, *Lymantria dispar*. Proc. Natl. Acad. Sci. USA, Vol. 87, pp. 2461-2465.

Entomophaga maimaiga (Entomophthorales: Entomophthoraceae) is a virulent fungal pathogen of the gypsy moth. It is considered to be an important natural mortality factor affecting gypsy moth populations in Japan, where it periodically causes extensive epizootics that in some instances can completely destroy an outbreak population.

In 1910-1911, a fungus now believed to be *E. maimaiga* was imported from Japan via infected gypsy moths and subsequently was released at several locations near Boston. This Japanese "gypsy fungus", as it was referred to, was thought to have failed to establish itself, however, because of an outbreak of nuclear polyhedrosis virus (NPV), which apparently caused a collapse in the host gypsy moth population. The fungus was never recovered, and despite numerous surveys, neither *E. maimaiga* nor any other entomophthoralean fungus has ever been observed in North American or European gypsy moth populations.

In early June 1989, large numbers of dead and dying gypsy moth larvae were found clinging to the trunks of trees throughout many forested and residential areas of the northeastern United States. Microscopic examination of these larvae revealed the presence of a fungal pathogen morphologically identical to *E. maimaiga*, thus representing the first reported occurrence of this fungus in North American gypsy moths. (See Hajek et al., page 3 of this document).

DISCUSSION

The characteristic disease symptomatology displayed by infected gypsy moths in the field, with larvae dying as late instars and clinging to the bark of trees with their heads facing downward and laterally compressed bodies, are also virtually identical to those reported in outbreak populations in Japan, where epizootics of *E. maimaiga* occur regularly. Additional confirmation on the identity of this fungus is reflected in the strong specificity of *E. maimaiga* for *L. dispar*. This has been demonstrated in transmission tests in which native gypsy moth larvae have shown susceptibility only to isolates of *E. maimaiga* originating from Japanese gypsy moths and have never been infected successfully by any North American isolates of *Entomophaga* from other lepidopteran hosts. Further corroboration has come from recently completed isoenzyme comparisons, which have shown that the two fungal isolates from Japan and North America are identical (Hajek et al., page 3 of this document).

Based on the high prevalence and widespread distribution of the fungus in gypsy moth populations throughout the northeastern United States, it appears that the epizootic was not the result of a recent introduction, and that this fungal pathogen has probably been present in gypsy moth populations for some time. Reasons for its sudden and dramatic occurrence are not entirely clear. The first reported introduction of *E. maimaiga* into North America was

by Speare and Colley nearly 80 years ago. Although they never recovered the fungus, it is possible that it may have survived via resting spores and spread slowly through the gypsy moth population. In summarizing their experiments, Speare and Colley speculated that "should it (*E. maimaiga*) obtain a foothold in the field, it might be expected to prove continuously effective from season to season, owing to its habit of forming resting spores in great abundance, which experiments have shown are able to survive the New England winter, and a very slight increase in virulence, such as often appears in parasitic fungi in successive seasons, might bring about quite different results".

RESULTS

Fungal Description. The hyphal bodies found in fresh cadavers are unicellular, irregular to sac-like in shape, and multinucleate. They give rise to simple, unbranched conidiophores that grow out through the integument and form a velvet-like coating over the body of the infected larva.

Infections are initiated by germinating conidia, which penetrate the integument of the larval host. Infected larvae usually die prior to pupation and characteristically cling by their prolegs to the substrate (tree trunk) with their heads pointing downward. Most infected cadavers show no external fungal growth in the field but are filled internally with resting spores. They become laterally compressed in the absence of moisture and remain attached to trees for several months.

Second- to fourth-instar larvae that were infected in the laboratory via conidial showering usually died within 7-10 days when held under 100 percent relative humidity at 20°C.

Distribution. Fungal-infected larvae were found throughout all gypsy moth-infested areas of western Connecticut (108 townships in six counties: Fairfield, Hartford, Litchfield, Middlesex, New Haven, and Tolland) (see Figure 1). Although we were not able to quantify infection rates, the highest prevalence of the disease appeared to be in southwestern Connecticut, where the gypsy moth populations were the largest and caused extensive defoliation. However, the fungus was also found along the leading eastern edges of the infestation, where gypsy moth populations were very low (<100 larvae/ha). Fungal-infected larvae were also detected in many other widely separated areas of the northeastern United States. These included: southern Vermont (Bennington and Windham Counties), New Hampshire (Cheshire and Merimack Counties), central (Franklin and Worcester Counties) and western (Berkshire County) Massachusetts, southern (Putnum and Westchester Counties) and eastern (Washington County) New York, northern New Jersey (Bergen, Hunterdon, Mercer, Morris, and Sussex Counties) and at one locale in Pennsylvania (Monroe County). No fungus was found in larval samples from southeastern (Strafford County) and northern (Carroll County) New Hampshire or southern (Salem County) and far western (Warren County) New Jersey.

Impact on the Gypsy Moth Population. A total of 66,507 ha of residential and forested land, mostly in southwestern Connecticut experienced gypsy moth defoliation in excess of 10 percent. However, only 16,263 ha were severely defoliated (>75 percent), and more than half of the acreage (34,766 ha) was defoliated <25 percent.

Significant declines in gypsy moth egg mass densities (from -40 to -2,727 egg masses per ha) were observed in most areas of southwestern Connecticut that experienced noticeable defoliation during the season. Conversely, notable increases in the population (87 to 15,850 egg masses per ha) were generally seen along the leading edge of the infestation, where defoliation was negligible (<10 percent) in 1989. Where no egg masses were detected in the spring, no egg masses were found in the fall.

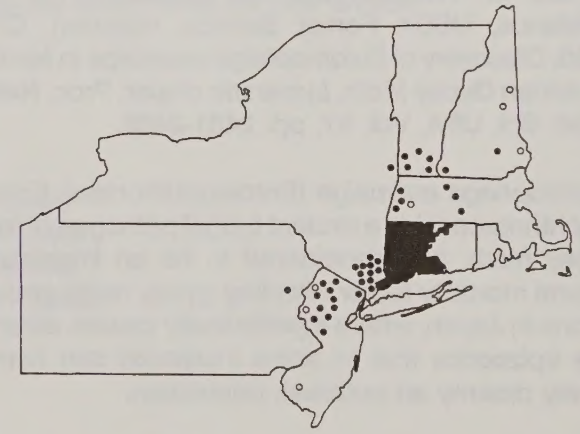

FIG. 1. Distribution of *E. maimaiga* in gypsy moth populations in the northeastern United States. Black circles and areas denote the presence of the fungus and open circles represent larval samples without fungus.

ENTOMOPHAGA MAIMAIGA RESPONSIBLE FOR 1989 EPIZOOTICS IN NORTH AMERICAN GYPSY MOTH POPULATIONS

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Article adapted from: Ann E. Hajek, Richard A. Humber, Joseph S. Elkinton, Bernie May, Scott R.A. Walsh, and Julie C. Silver. 1990. Allozyme and restriction fragment length polymorphism analyses confirm *Entomophaga maimaiga* responsible for 1989 epizootics in North American gypsy moth populations. Proc. Natl. Acada. Sci. USA, Vol. 87 pp. 997-1000.

In 1989, northeastern gypsy moth populations were starting to increase after 7-8 years at low densities. Extensive mortality occurring in 1989 North American gypsy moth populations was caused by a previously unreported pathogen in the fungal group Entomophthorales. The dramatic impact of this pathogen on less dense populations of gypsy moth necessitated identification of this fungus and documentation of its impact.

Azygospores and conidia typical of fungi in the *Entomophaga aulicae* species complex were produced by cadavers of gypsy moth larvae collected in 1989. The *E. aulicae* species complex has been collected worldwide in the northern hemisphere and members infect hosts in nine families of Lepidoptera. A taxonomist recently suggested that it may also be in the southern hemisphere. This complex is at present poorly defined and only one species within it, the gypsy moth pathogen *Entomophaga maimaiga*, has been adequately described. Based on morphology, development, and pathology, the 1989 northeastern fungus appeared to be *E. maimaiga*. *E. maimaiga* was previously known only for gypsy moth populations in Japan, where many epizootics have been reported.

RESULTS

From survey samples, the presence of *E. maimaiga* was detected in seven contiguous northeastern States (Massachusetts, Connecticut, New Hampshire, Vermont, New York, Pennsylvania, and New Jersey). Based on the documented spread of defoliation by gypsy moth populations between 1910 and 1987, the current *E. maimaiga* panzootic occurred in many areas where gypsy moth populations caused defoliation in 1934 and 1957 but not in all areas defoliated in 1980. In addition, many of the areas that gypsy moth populations have colonized more recently and where *E. maimaiga* was not evident (e.g., central Pennsylvania and western New York state) received abundant rainfall during spring 1989. If this fungus was present, we would expect to be able to detect it. *E. maimaiga* was not found in samples collected from the sites in southwestern New York and northwestern Virginia where a 1984 Japanese isolate of *E. maimaiga* was released in 1985 and l986 (A.E.H. and R.S. Soper, unpublished data).

In four research plots in central Massachusetts, mortality from *E. maimaiga* among late-instar larvae ranged from 60 percent to 88 percent. Despite these high levels of mortality, there was relatively little change from 1988 to 1989 in gypsy moth egg mass densities, which remained well below outbreak levels. Because of the high fecundity of gypsy moths (ca. 600 eggs per mass in these populations), mortality in immature stages in excess of 80 percent may not be sufficient to cause population decline. The results suggest that without the mortality due to the *E. maimaiga* epizootic, a marked increase in gypsy moth density probably would have occurred.

DISCUSSION

High levels of mortality due to *E. maimaiga* occurred in late instars even in the low level populations in central Massachusetts. In higher density populations in Connecticut, fungal infection levels were not quantified, but *E. maimaiga* was considered to have prevented extensive defoliation, The importance of *E. maimaiga* mortality in low as well as high density populations suggests that the activity of this pathogen may be less dependent on host density than the virus. Unfortunately, the overall impact of *E. maimaiga* on gypsy moth populations cannot be known because fungal infection levels in early instars during 1989 epizootics were not documented.

The widespread epizootics caused by this previously unreported fungus specific to gypsy moth raises questions regarding the origin of *E. maimaiga* in North America. Based on samples taken in New York and Virginia following 1985 and 1986 field releases of the 1984 Japanese isolate *E. maimaiga*, this isolate of *E. maimaiga* caused only extremely low levels of infection. No evidence of *E. maimaiga* was found among cadavers collected from these release sites during 1989. Thus, it is highly unlikely that the 1989 epizootics were derived from these recent small-scale intentional introductions of *E. maimaiga*. Instead, the near-ubiquitous occurrence of *E. maimaiga* in regions long infested by gypsy moth suggests a much earlier introduction.

It is most likely that *E. maimaiga* may not have been detected in previous years because cadavers of larvae killed by *E. maimaiga* look very similar to cadavers of virus-killed larvae to untrained observers; the conidia and conidiophores present externally on cadavers are very short lived and usually only microscopic examination confirms the presence of *E. maimaiga*. Also, *E. maimaiga* may not be common most years. High humidities are required for conidial production, and free water is necessary for conidial germination. Rainfall in May 1989 was the second highest on record since 1931 in Connecticut and western Massachusetts, and June rainfall was well above average. Furthermore, gypsy moths were relatively abundant in 1989 compared with many years during which densities are so low that larvae are almost never observed and mortality would go unnoticed.

Previous analyses of long-term data on gypsy moth egg mass density collected between 1911 and 1932 at sites throughout the northeastern United States indicated the June rainfall was strongly associated with population decline. In particular, a collapse of high density populations in 1922 was associated with heavy June rainfall. Such population declines have usually been attributed to epizootics of virus. Other studies conducted in 1958-1963 revealed that disease incidence was higher on wetter sites, leading to the belief that wet years promote epizootics of virus. Preliminary laboratory studies indicated a positive relationship between relative humidity and incidence of virus; however, these findings have not been subsequently corroborated. Late instar gypsy moth larvae acquire lethal infections of virus primarily by ingesting foliage contaminated with virus occlusion bodies deposited by dying larvae. Rain might promote virus infections by dispersing virus more evenly across the habitat, but rain is also known to wash such particles from the foliage (thereby reducing inoculum available to gypsy moth larvae). Given the similar appearance of larvae killed by virus and *E. maimaiga*, we suspect that many previous collapses of high density gypsy moth populations in North America correlated with wet conditions may in fact have been caused by *E. maimaiga*.

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Editor's Note: As gypsy moth populations increase, so does the concern among State agencies about where to find the money necessary to operate a gypsy moth treatment program.

In West Virginia, this concern resulted in a return to the old American adage, "you get what you pay for". In the following article, Alan Miller, West Virginia Department of Agriculture, describes West Virginia's solution to an increased demand for a service, but less State funds to provide it. Economists might be interested in this approach because of its documentation of the public's "willingness to pay".

GYPSY MOTH SUPPRESSION IN WEST VIRGINIA: THE COOPERATIVE STATE-COUNTY-LANDOWNER PROGRAM

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Though many States are faced with budget deficits and the money normally supplied by legislative bodies may not be forthcoming or inadequate to support an increased demand for treatment of gypsy moth, there is a way to still provide the requested service.

How it works in West Virginia. The Plant Industries Division of the West Virginia Department of Agriculture was provided money from the State Legislature

to treat gypsy moth from 1983-1987. However, in 1987, the Legislature did not provide money for treatment in 1988 and the Cooperative State-County-Landowner Program became a reality. The Commissioner of Agriculture, by law, cannot enter into an agreement with separate landowners, but the Commissioner can sign agreements with the respective County Commissions. In West Virginia, an agreement was drafted and signed with the County Commissioners that laid out a suppression program for gypsy moth. Basically, the agreement is one in which the West Virginia Department of Agriculture Plant Industries Division has set forth guidelines for inclusion into a treatment program. The Plant Industries Division staff provides egg mass surveys, assists in marking boundary lines of property on topographic maps, and administers the treatment project. The County Commissions, through the county agent, conduct a sign up period for landowners desiring treatment of gypsy moth on their lands. The County Commision also collects the money paid by landowners into one central pool, either the Sheriff's office or County Clerk's office. This office in turn presents one check from each county to WVDA to cover all landowners' cost in the program. The WVDA then purchases chemicals needed for the project, prepares an environmental assessment, seeks cooperative money from the USDA Forest Service, solicits bids for aerial contracts, and administers the actual treatment of the landowners' property.

The breakdown of costs for the program is 57 percent of total cost is paid by landowners and 43 percent is paid by the USDA Forest Service. The only State money incurred in the program is State personnel time to administer and conduct the project. Several guidelines have been set forth for landowners to qualify and include: a minimum of 50 contiguous acres, have an adequate stocking of oak or host trees, and have a minimum of 250 egg masses per acre. Other factors can be included, such as recreation areas, chance of blow-in from adjoining lands or extreme nuisance problem. Housing developments and other multiple ownership lands to be treated are required to select one individual that represents and collects the money for this development or group of landowners. This individual is the person that signs with the county to treat the proposed tract of land.

In order to understand the actual workings of the Program, the following is a step-by-step progression of an actual sign up by a landowner.

Mr. G.P. Moth would like to have his 1,000-acre tract of land checked for gypsy moth to see if suppression is needed. Mr. Moth either calls the county agent's office or visits the office and leaves his name, address and telephone number on a gypsy moth sign up sheet. The sign up period is August 1 through October 1. The county agent may or may not visit or talk with the individual during the sign up.

After the sign up, the landowner is contacted to determine where his land is located and how many forested acres are involved. If the acreage is less than 50 acres, the landowner is urged to contact his neighbors and collectively find 50 acres or pursue treatment with a private applicator. The landowner is also told that one individual has to represent multiple ownerships in such cases. In the sign up of Mr. Moth, the land consists of 1,000 acres. The field agent will travel to Mr. Moth's property and proceed to make 1/40-acre egg mass surveys and determine if the property meets the guidelines set forth in the agreement. All information is placed on a form and the area is either accepted or rejected. Mr. Moth also has to supply a map of his property.

In the case of Mr. Moth, his area is accepted and he is told that the WVDA is recommending treatment and the two materials that are available in the State Program are Dimilin and *B.t.* He can select either. To help his selection, the WVDA can provide background information about either material. A deposit of $3 per acre for Dimilin or a deposit of $5 per acre for *B.t.* must be paid to the respective county commission office by Jaunuary 11, 1991. If he fails to make the deposit, his acreage will be removed from consideration.

After January 11, an environmental assessment is done, the material for treatment is purchased and the aerial contract bid is sent to prospective bidders.

Immediately following the selection of an aerial contractor, the final cost for treatment is obtained. Each individual that has sent a deposit is notified that additional money is needed or a refund is due. The additional money is normally due in two weeks after the actual billing. The money is again paid to each respective County Commission. Refunds are not

paid until the project is completed. The County Commission sends one check to WVDA to cover additional cost of the program. In Mr. Moth's case, he submitted $3,000 for 1,000 acres to be treated with Dimilin. The actual cost for the project was $6 per acre. Mr. Moth's share would be 57 percent of $6,000 or $3,420. Mr. Moth has paid $3,000, so now he owes $420 to cover the cost of the treatment. In the West Virginia project if the $420 is not sent, the deposit is not refunded, but can be applied to a future project. The USDA Forest Service, through a cooperative agreement, pays 43 percent of the total cost.

The State-County-Landowner Program has been a proven success in West Virginia. During 1988, 33,541 acres were treated; in 1989, 51,039 acres were treated; and in 1990, 78,820 acres were treated in this Program. The cost to landowners in each year has been less than $4 per acre for Dimilin and less than $5 per acre for *B.t.*

Additional questions about the Program should be directed to the West Virginia Department of Agriculture at 304-348-2212 and talk to Charles C. Coffman or Alan R. Miller.

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NEW INFORMATION

Gypsy Moth Suppression In the Northeast: A 3-Year Summary of the Treatment Monitoring Data Base by D. Twardus and H. Machesky. Rpt. No. NA-TP-18, July 1990. USDA Forest Service, Northeastern Area, State and Private Forestry, 5 Radnor Corporate Center, 100 Matsonford Road, Suite 200, Radnor, PA 19087. Copies of this publication can be obtained from Forest Pest Management, 180 Canfield Street, Morgantown, WV 26505.

This paper summarizes gypsy moth project effectiveness in meeting objectives, 1986-1989.

Annual Progress Report - 1989 by the USDA Forest Service Gypsy Moth Research and Development Program, M. McFadden, Program Manager. USDA Forest Service, Northeastern Forest Experiment Station, 5 Radnor Corporate Center, 100 Matsonford Road, Suite 200, Radnor, PA 19087.

This report describes the status of 73 on-going research projects funded to university, State and Forest Service investigators. The report is divided into:

gypsy moth effects on forests
gypsy moth biology
gypsy moth management
models

An excellent source for who's doing what and where in Forest Service related research.

The Appalachian Integrated Pest Management Gypsy Moth Demonstration Project, Fiscal Year 1990. A. Bullard, Program Manager. USDA Forest Service, Northeastern Area, State and Private Forestry, 180 Canfield Street, Morgantown, WV 26505.

This status report describes the project and some selected accomplishments.

Gypsy Moth by M. McManus, N. Schneeberger, R. Reardon and G. Mason. 1990. FIDL-162. USDA Forest Service, Forest Pest Management, Auditors Building, 201 14th Street and Independence Avenue, SW, Washington, DC 20250. Copies of this publication can be obtained from the USDA Forest Service in Hamden CT, or from Forest Pest Management Offices in Morgantown, WV, and Washington, DC.

This general audience leaflet provides an update to existing knowledge about the biology, effects, and management of gypsy moth. 13 pages.

GYPSY MOTH SUPPRESSION, 1990

State / Site	Dimilin	Bt	Other*	Total
DELAWARE				
Cooperative Suppression	42,462	15,256	0	57,718
IDAHO (co-op eradication)				
Couer d'Alene/Sandpoint	0	1,060 (3X)**	0	1,060 (3X)
MARYLAND				
Cooperative Suppression	83,595	104,128	0	187,723
Aberdeen Proving Ground	0	8,000 (2X)	0	8,000 (2X)
Adelphi Laboratory	70	30	0	100
Annapolis Naval Reservation	0	180 (2X)	0	180 (2X)
C&O Canal & GW Parkway	0	986	0	986
Fort Meade	0	6,300	0	6,300
Greenbelt ACE	0	247 (2X)	0	247 (2X)
Greenbelt & BW Parkway	0	1,108 (2X)	0	1,108 (2X)
NASA-Goddard	0	1,197 (2X)	0	1,197 (2X)
White Oak Naval Center	226	40	0	266
Pautuxent Wildlife Center	0	3,550 (2X)	0	3,550 (2X)
USDA-ARS Research Center	0	2,943 (2X)	0	2,943 (2X)
Youghiogheny Lake	0	16	0	16
MICHIGAN				
Cooperative Suppression	0	143,240	0	143,240
Huron-Manistee Nat'l Forest	0	784	0	784
NEW JERSEY				
Co-op Suppression (NJ Ag)	0	92,997	0	92,997
Co-op Suppression (NJ For.)	575	7,830	0	8,405
NEW YORK				
Seneca Indian Nation	0	1,980 (2X)	0	1,980 (2X)
NORTH CAROLINA (co-op eradication)				
Bert, Halifax, Northam Co.	0	4,200 (2X)	0	4,200 (2X)
PENNSYLVANIA				
Cooperative Suppression	117,888	274,232	0	392,120
Bureau of Prisons	127	0	0	127
Conemaugh Lake	0	150	0	150
Cowanesque Dam	0	102	0	102
Crooked Creek Lake	0	324	0	324
Fort Necessity Park	0	400 (2X)	0	400 (2X)
Gettysburg National Batfld.	0	56 (2X)	0	56 (2X)
Loyalhanna Lake	0	42	0	42
Mahoning Creek Lake	0	62	0	62
Raystown Lake	0	80	0	80
Youghiogheny Lake	0	164	0	164
TENNESSEE (co-op eradication)				
Sequatchie County	0	0	200	200
UTAH (co-op eradication)				
Wasatch Front	0	20,064 (3X)	0	20,064 (3X)
VERMONT				
Cooperative Suppression	0	8,050	0	8,050
Green Mountain Nat'l Forest	0	3,202	0	3,202

State / Site	Dimilin	Bt	Other	Total
VIRGINIA				
Cooperative Suppression	92,999	34,616	0	127,615
AIPM Project	27,220	59,081	811 (2X)	87,112 (2X)
Arlington National Cemetary	435	0	0	435
Blue Ridge Parkway	206	1,426	48 (2X)	1,680 (2X)
Dulles Airport	1,600	0	0	1,600
Fort Belvoir	137	0	0	137
Fredrick./Spots. Natl Batf.	0	230	0	230
GW Parkway	0	951 (2X)	0	951 (2X)
Manassas National Battlefld	0	186 (2X)	0	186 (2X)
Prince William Forest Park	0	654 (2X)	168 (2X)	822 (2X)
Quantico Marine Base	3,314	1,772	0	5,086
Shenandoah National Park	1,939	1,082	172 (2X)	3,193 (2X)
Smithsonian Zoological Park	100	0	0	100
Vint Hill Farms	185	0	0	185
Warrenton Training Center	371	0	0	371
WASHINGTON, DC				
National Arboretum	0	187 (2X)	0	187 (2X)
National Capital Parks	0	261 (2X)	0	261 (2X)
WEST VIRGINIA				
Cooperative Suppression	186,306	145	0	186,451
AIPM Project	104,133	61,478	500 (2X)	166,111
George Wash. Natl Forest***	1,145	7,501 (2X)	250 (2X)	8,896
Monongahela National Forest	615	4,566 (2X)	275 (2X)	5,456
Jennings Randolph	150	0	0	150
GRAND TOTAL-GYPSY MOTH TREATMENT	665,798	877,136	2,424	1,545,358

* Other includes gypchek and disparlure.
** (_X) indicates the number of applications in a multiple application project.
*** Includes AIPM area.

Note: Second application is not reflected in the totals

Data obtained from the National Pest Suppression Tracking System, Forest Pest Management, Morgantown, WV. Revised 9/11/90.

GYPSY MOTH DEFOLIATION, 1989-1990

STATE	1989	1990
District of Columbia	0	10
Delaware	1,888	3,790
Connecticut	78,430	176,576
Massachusetts	950	83,595
Maryland	97,911	133,062
Maine	35,000	270,433
Michigan	294,344	358,338
New Hampshire	18,395	133,200
New Jersey	137,310	431,235
New York	421,138	354,162
Ohio	0	115
Pennsylvania	1,506,790	4,357,700
Rhode Island	0	0
Vermont	27,335	63,000
Virginia	289,332	594,000
West Virginia	86,736	338,746*
TOTAL	2,995,559	7,297,962

* Subject to revision.

Note: Data obtained from the GMDigest, Forest Pest Management, Morgantown, WV.